

Asthma and Air Quality in the Presence of Fires – a Foundation for Public Health Policy in Florida

William Crosson¹, Mohammad Al-Hamdan¹, Maurice Estes Jr¹, Sue Estes¹, Jeffrey Luvall², Cody Sifford³, Linda Young⁴

¹Universities Space Research Association at NASA Marshall Space Flight Center, Huntsville, Alabama, USA.

²Earth Science Office at NASA Marshall Space Flight Center, Huntsville, Alabama, USA.

³Salish Kootenai College, Pablo, Montana, USA.

⁴University of Florida, Gainesville, Florida, USA.

Outdoor air quality and its associated impacts on respiratory problems in Florida are of public health significance. Air quality in Florida can be poor during the extended wildfire season, threatening persons with compromised respiratory systems each year. Studies have demonstrated that particulate matter, which is generally elevated in the vicinity of wildfires, is associated with increases in hospital admissions and occurrences of acute asthma exacerbations. However, few studies have examined the modifying effect of socio-demographic characteristics of cities or regional areas on the relationship between air quality and health outcomes.

In an ongoing university/multi-agency project, asthma hospital/emergency room (patient) data are being used to create a health outcome indicator of human response to environmental air quality. Environmental data are derived from satellite measurements, with special attention being given to the effect of wildfires and prescribed burns on air quality. This presentation will focus on the environmental data sets – particulate matter, location of fires, smoke plumes – that are being collected and processed for linkage with health data. After this linkage has been performed, space-time models of asthma rates as a function of air quality data and socio-demographic variables will be developed and validated. The Florida Department of Health (FDOH) will work with county health department staff and representatives from the medical community to establish a protocol with triggers for issuing public health advisories/alerts based on the developed and validated health outcome indicators. From this effort, a science-based policy for issuing public health advisories/alerts for asthma relating to air quality will be developed, giving FDOH the ability to (1) predict, with stated levels of uncertainty, case load of hospital admissions based on air quality, (2) reduce asthma exacerbations by forewarning asthmatics to limit outside activities on poor air quality days, (3) apply management practices on the rates of hospital/emergency room visits for asthma, and (4) provide information that would help translate interventions into policy decisions, thereby reducing the economic burden and increasing well being of asthmatics. Further, the results of the study will be incorporated into Florida's Environmental Public Health Tracking (EPHT) program, which is part of the Centers for Disease Control and Prevention's (CDC's) EPHT network.

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William Crosson, Universities Space Research Association
National Space Science and Technology Center, Huntsville, AL

Mohammad Al-Hamdan, Maury Estes, Sue Estes
National Space Science and Technology Center

Jeffrey Luvall
NASA Marshall Space Flight Center, Huntsville, AL

Linda Young, Kenneth Lopiano
University of Florida, Gainesville, FL

Cody Sifford
Salish Kootenai College, Pablo, MT

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Project Motivation

- Outdoor air quality, especially high levels of fine particulate matter ($\text{PM}_{2.5}$) is believed to have adverse effects on respiratory health, leading in increased Emergency Room (ER) visits and hospitalizations
- Wildfires and some prescribed burns lead to increased levels of $\text{PM}_{2.5}$.
- The association between reduced air quality resulting from wildfires and/or prescribed burns and the incidence of asthma is unknown.
- Wildfire and prescribed burn data are being used in this study to assess whether the presence of these environmental hazards are related to the health outcome of asthma as measured by hospitalizations and ER.

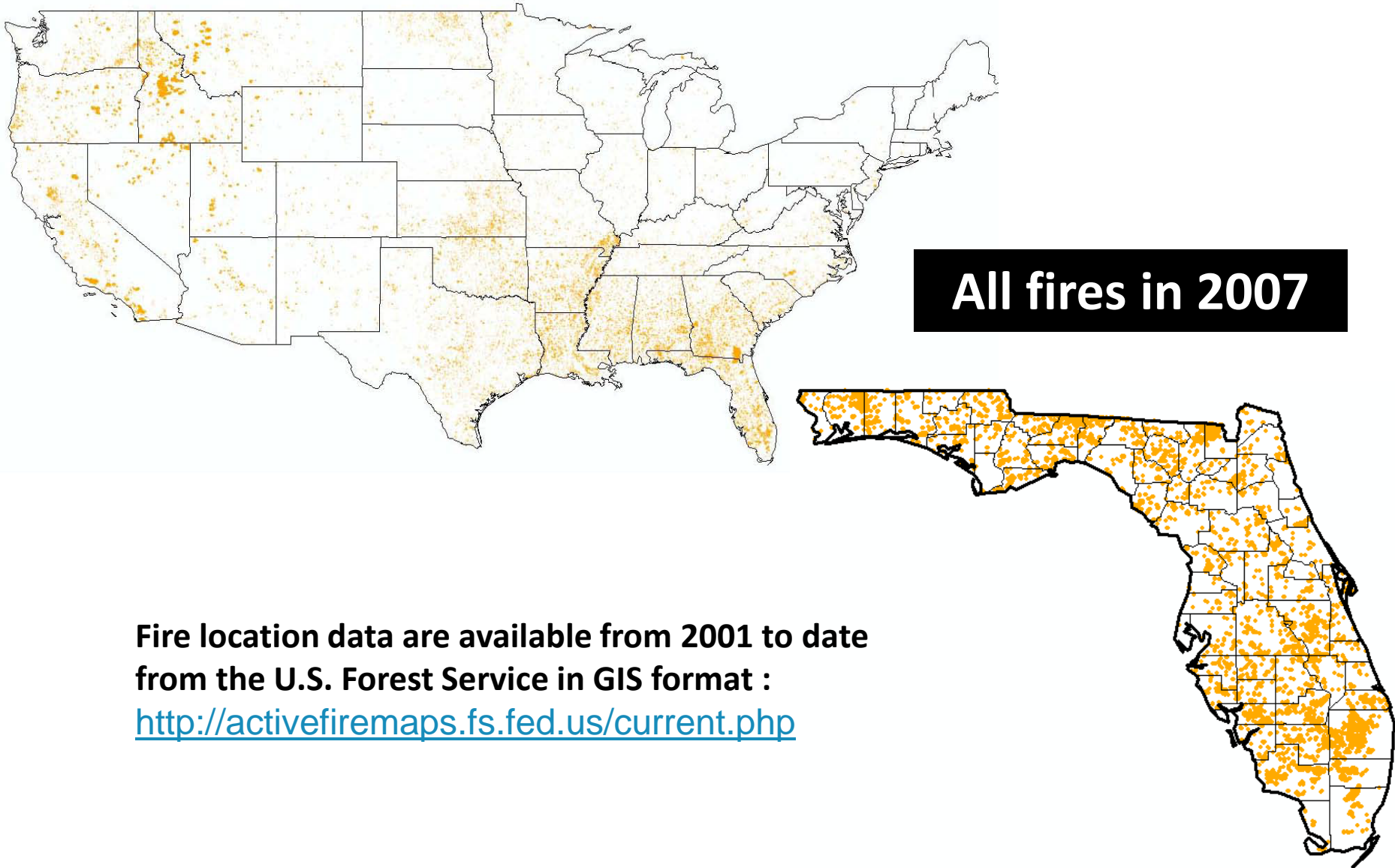
Project Objectives

- **Develop high-quality spatial data sets of environmental variables**
- Link these environmental data sets with public health data consisting of hospitalization admissions and ER visits associated with asthma and socio-demographic variables
- Develop spatial-temporal models of the association between asthma and air quality
- Provide the linked data sets and associated analyses to the State of Florida to assist them in establishing a public health policy for posting county-level advisories and alerts of poor air quality, with associated steps citizens should take to protect their health

Environmental Data Sets

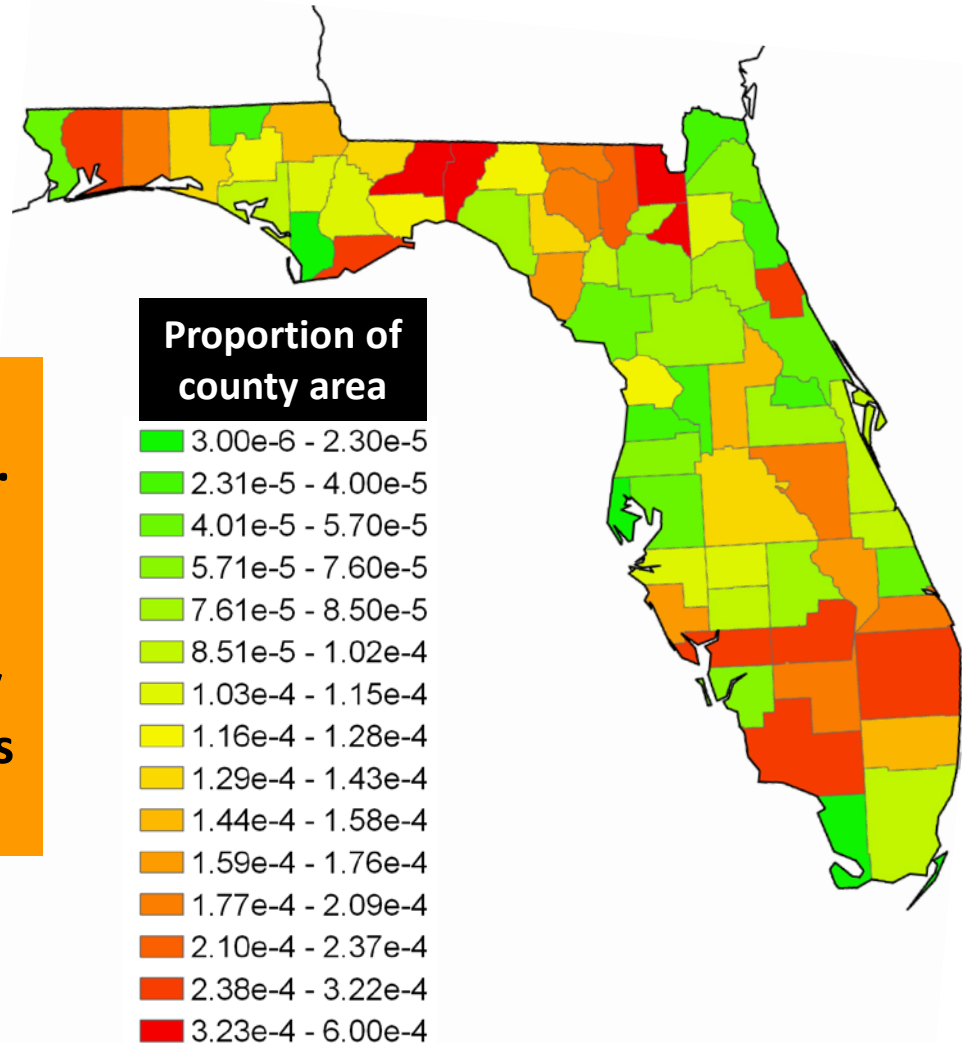
- MODIS-detected active burn areas
 - Daily, 1 km grid
 - Temperature and Fire Radiant Power provided
- NOAA smoke plumes
 - Daily vector (polygonal) data
- MODIS Aerosol Optical Depth (AOD)
 - Daily, 10 km grid
 - Correlates well with surface $PM_{2.5}$ under certain conditions
- Ground $PM_{2.5}$ measurements from EPA Air Quality System (AQS)
 - Daily to every 6 days
 - Point data, spatially sparse

MODIS Fire Locations

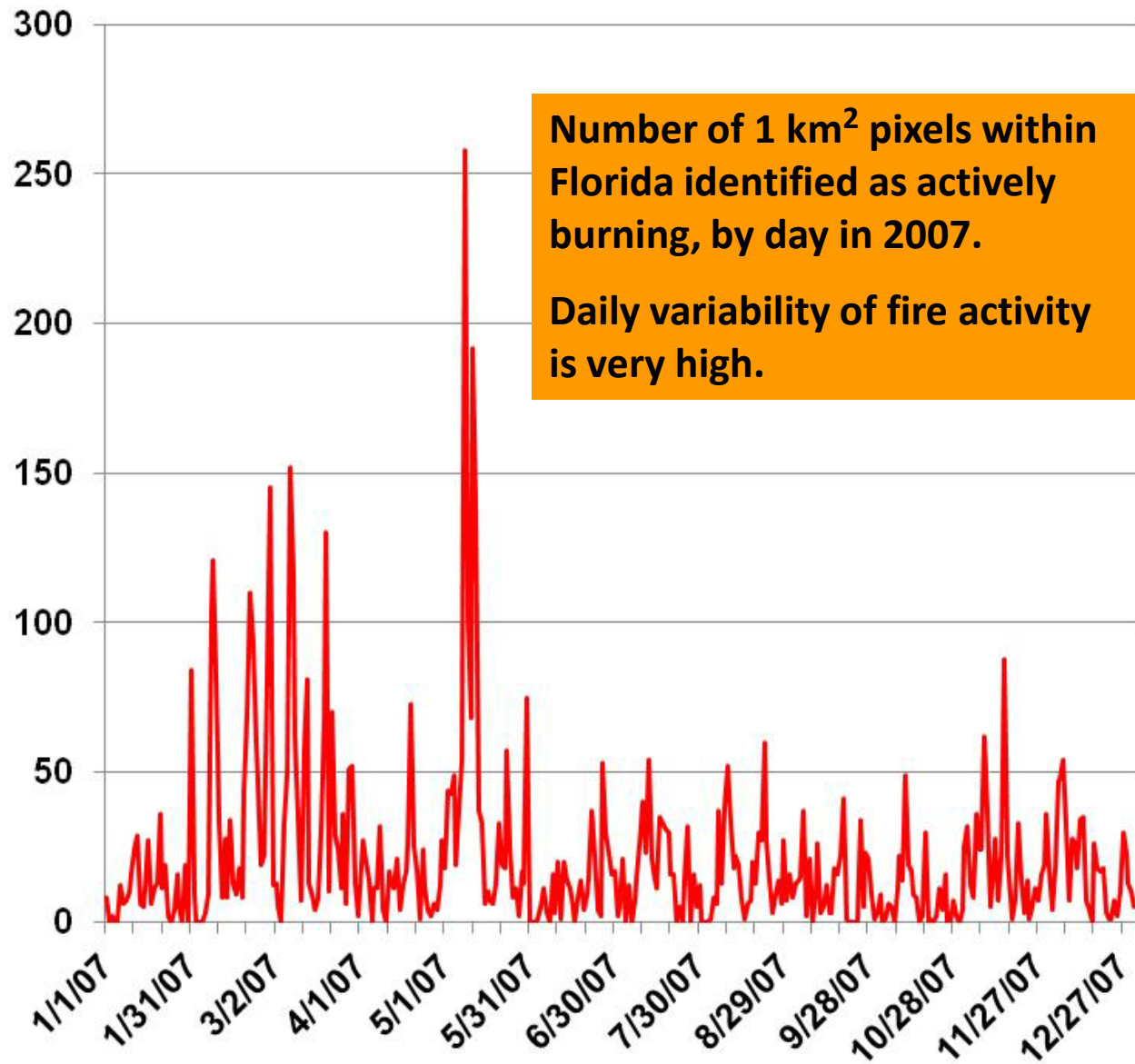


Fire area by County

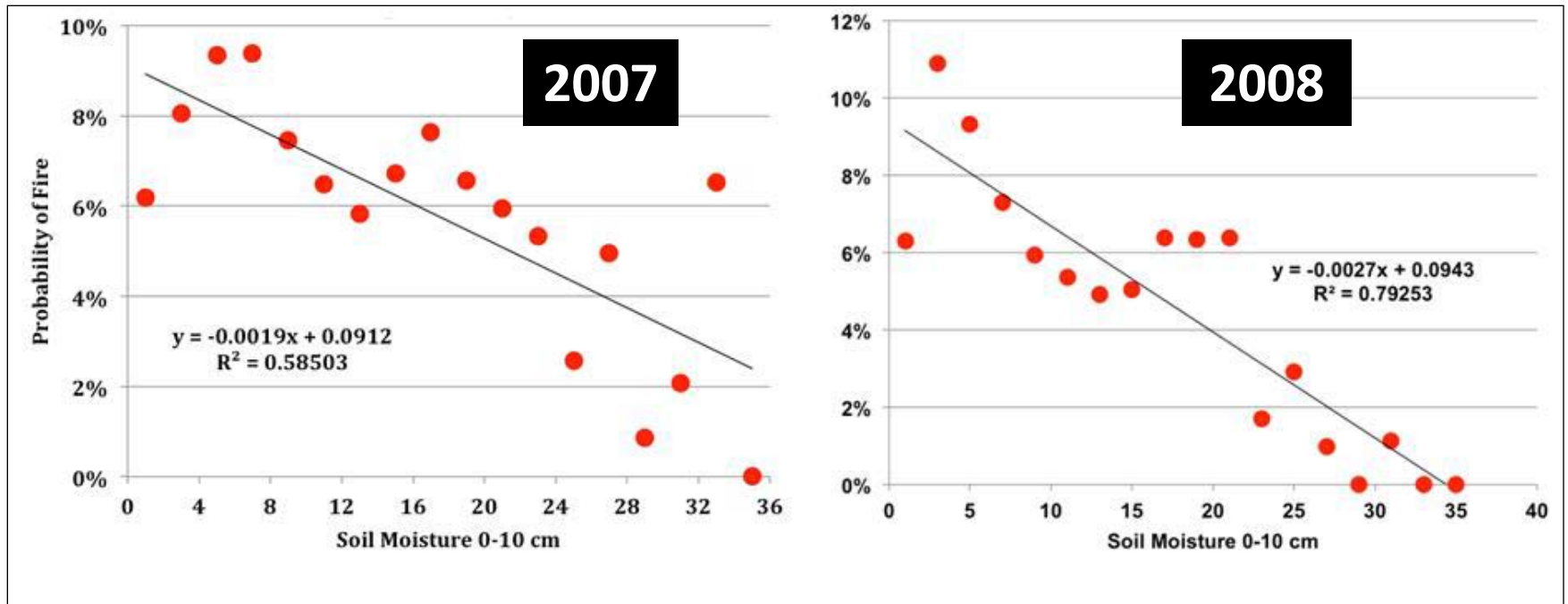
Daily fire data have been aggregated to the county level. Shown here are the daily proportions of land area in each county that were actively burning, averaged over all days in 2007.



Fire Time Series

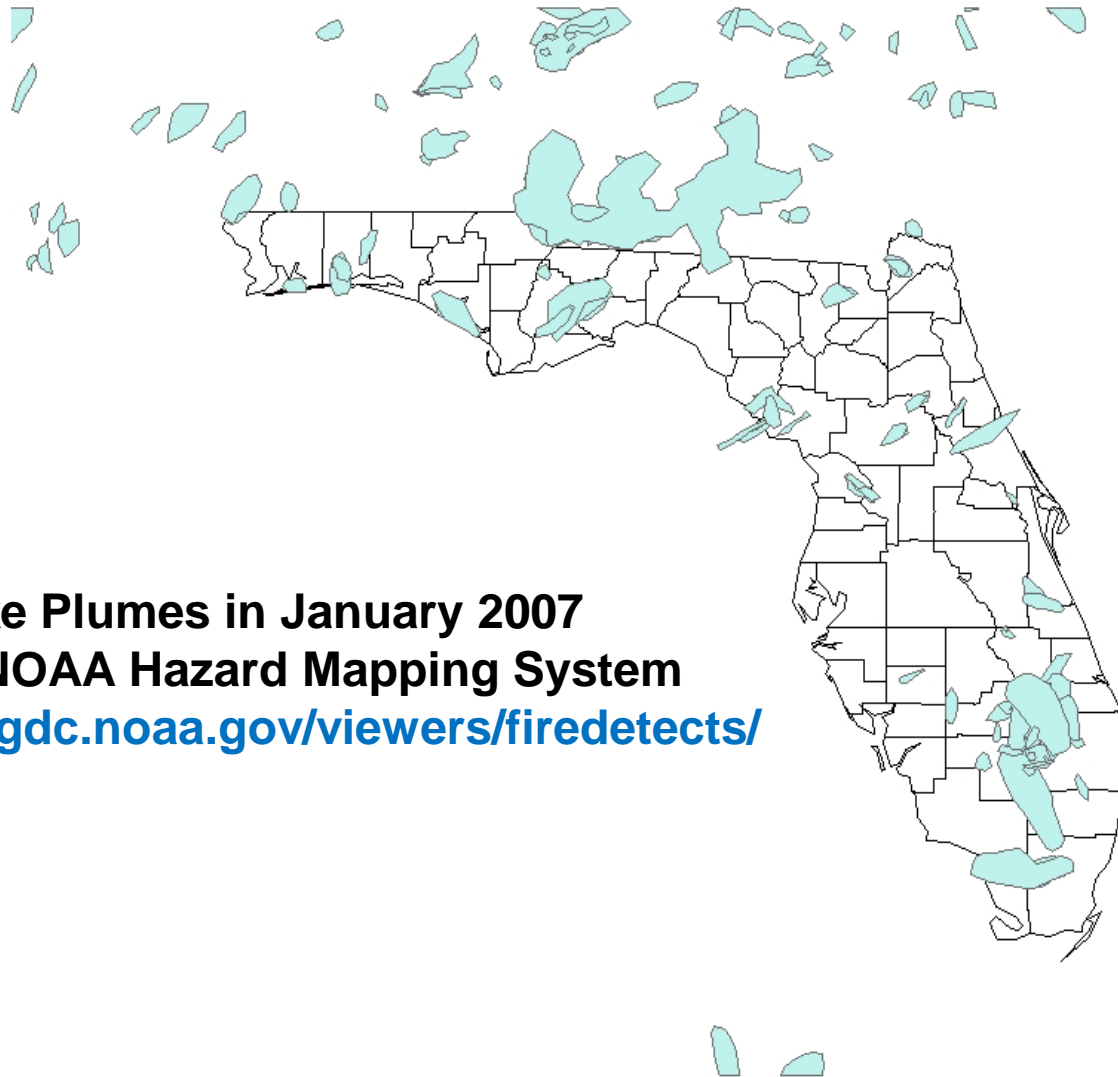


Fire – Soil Moisture Relationship



At the county level, probability of fire correlates well with soil moisture in the 0-10 cm layer.

Smoke Plumes



Smoke Plumes in January 2007

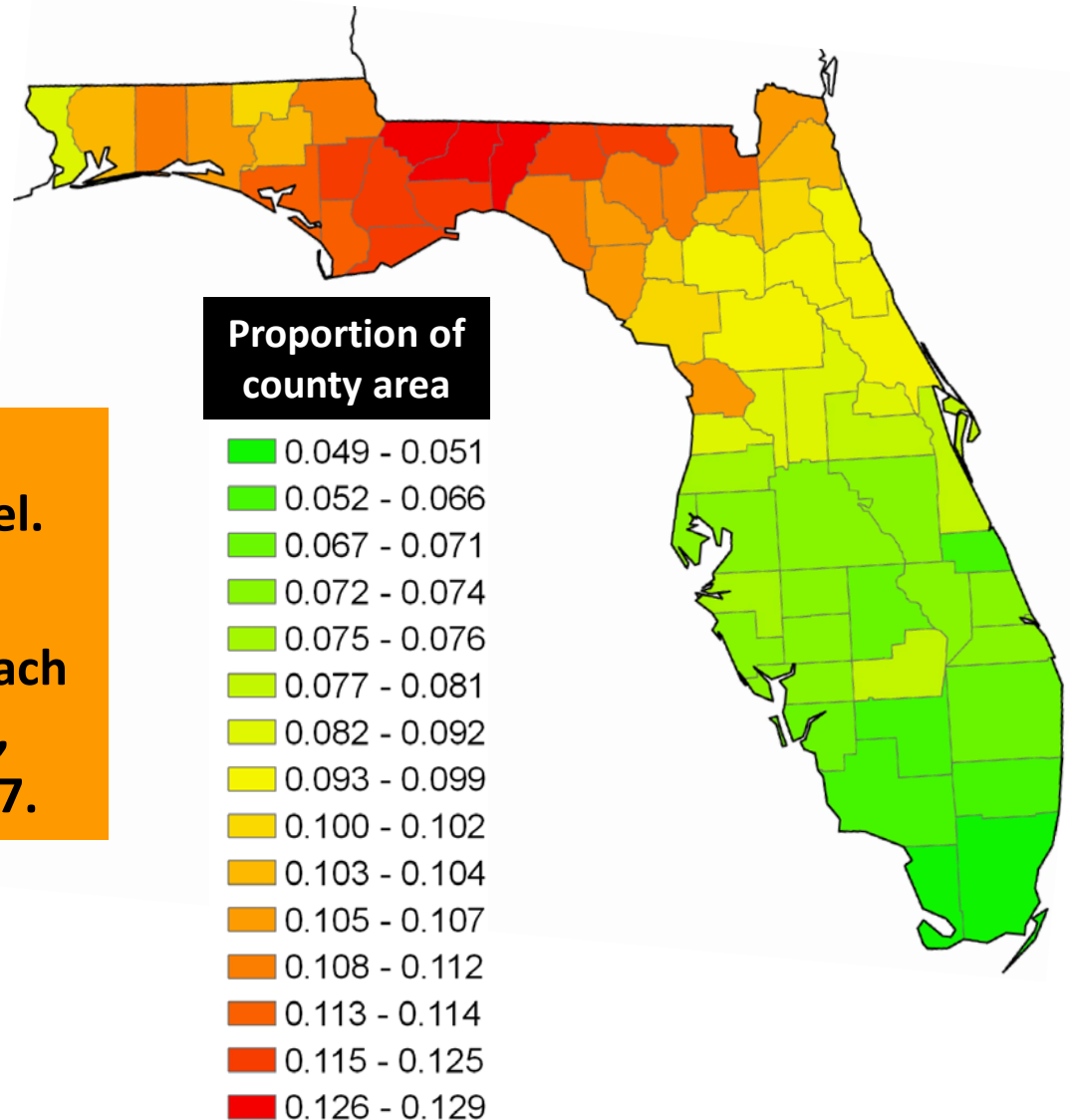
Source: NOAA Hazard Mapping System

<http://maps.ngdc.noaa.gov/viewers/firedetects/>

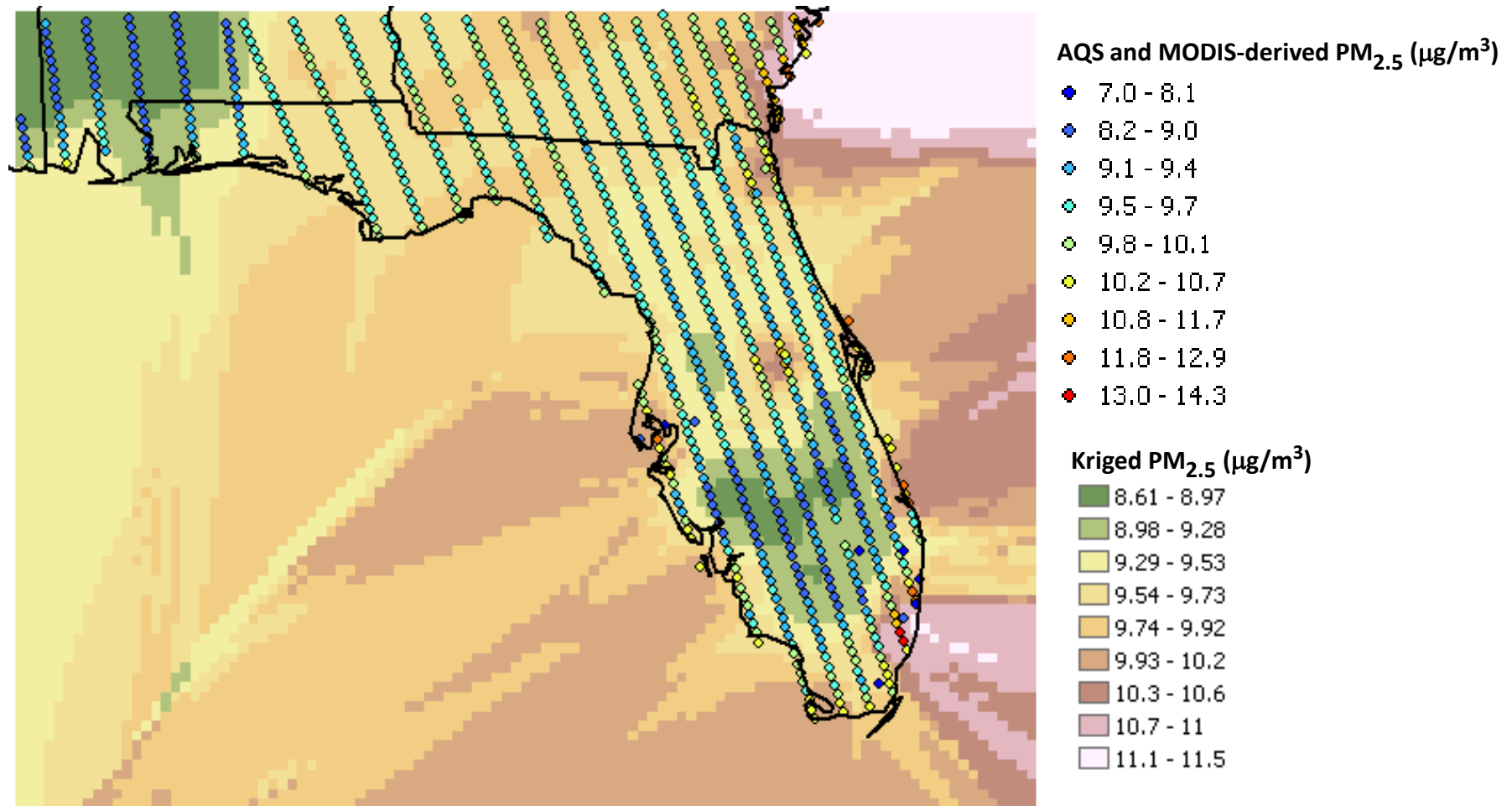
Smoke area by County

Daily smoke data have been aggregated to the county level.

Shown here are the daily proportions of land area in each county within smoke plumes, averaged over all days in 2007.



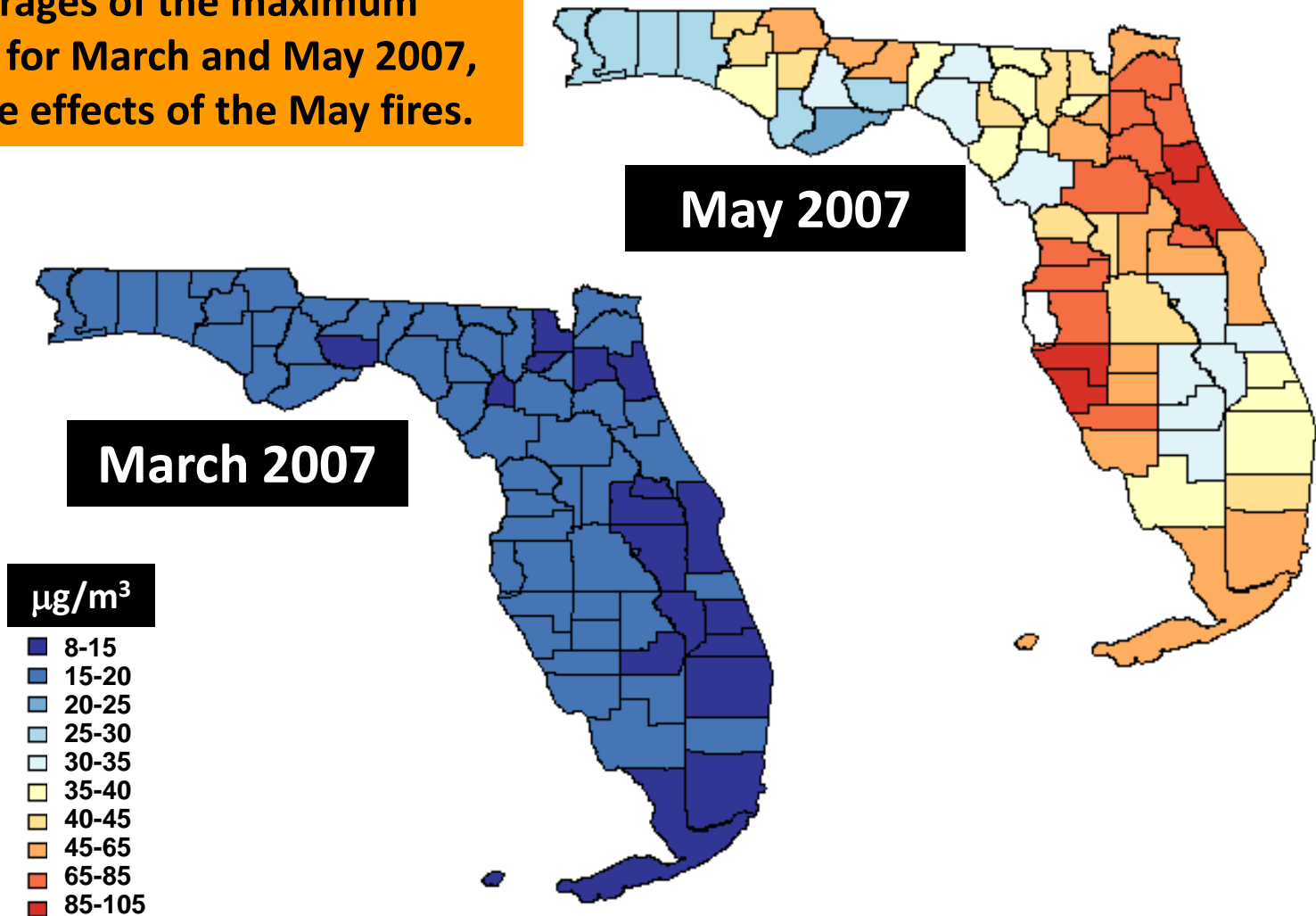
MODIS/AQS PM_{2.5}



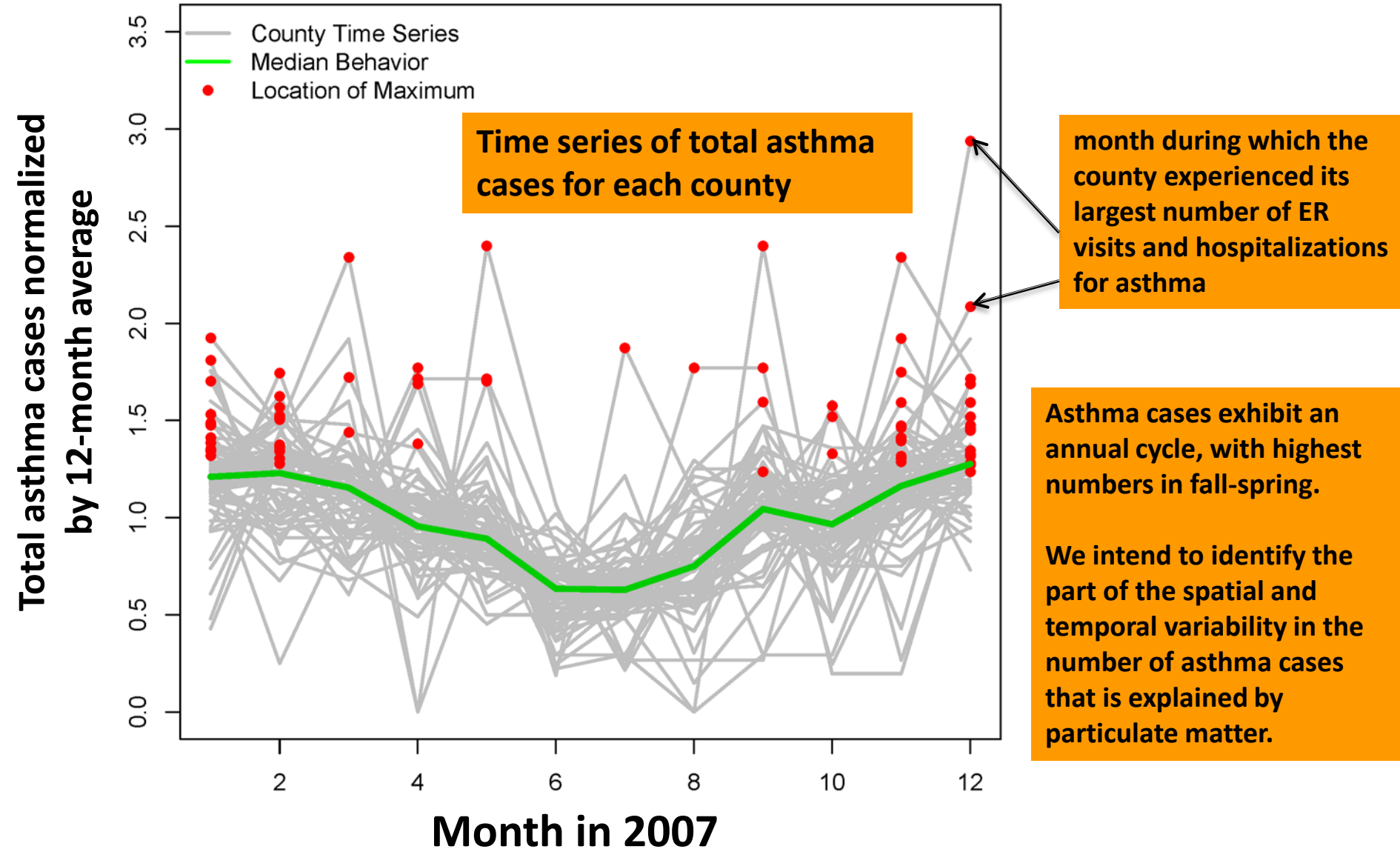
Daily PM_{2.5} spatial fields have been created from AQS ground observations and MODIS AOD. Shown here is an example for April 16, 2007, a day with near complete MODIS coverage, in which kriging was used to create the spatial surface.

Monthly Maximum PM_{2.5} by County

County averages of the maximum daily PM_{2.5} for March and May 2007, showing the effects of the May fires.



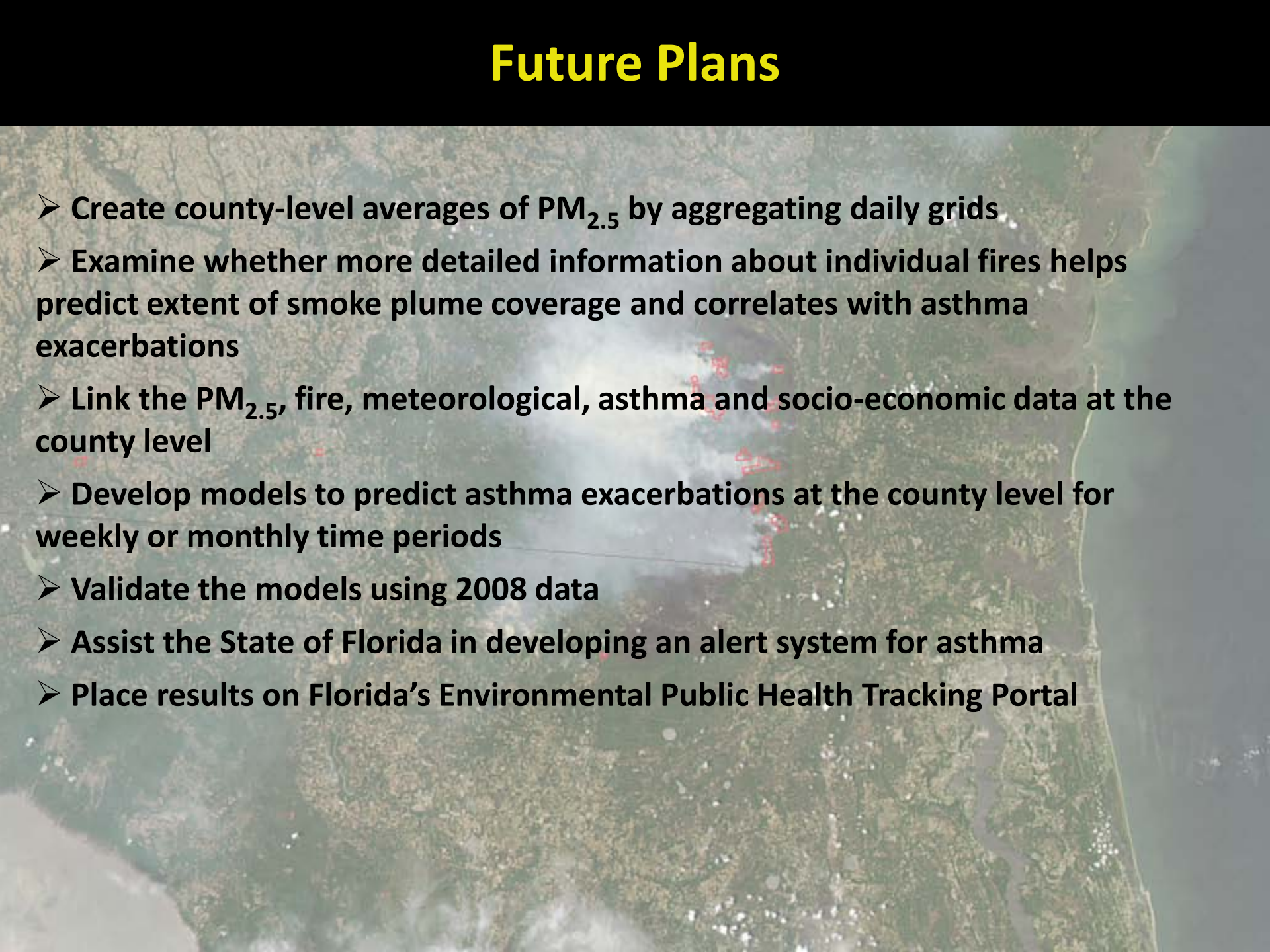
Health Data



Summary

- We have assembled a large dataset characterizing environmental conditions at high temporal (mostly daily) and spatial resolution (1-10 km) for linkage with public health data (ER visits and hospitalizations for asthma).
- Fire and smoke data have been aggregated to the county level, the geographic unit of preference for many public health practitioners and state/county agencies.
- Daily spatial surfaces of $PM_{2.5}$ have been generated using a combination of AQS $PM_{2.5}$ ground observations and estimates made via a regression model based on MODIS Aerosol Optical Depth (AOD).

Future Plans

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- An aerial photograph of a coastal region, likely in Florida, showing a large white smoke plume rising from a fire area marked with red dots. The background is a dark, textured map of the land and water.
- Create county-level averages of $PM_{2.5}$ by aggregating daily grids
 - Examine whether more detailed information about individual fires helps predict extent of smoke plume coverage and correlates with asthma exacerbations
 - Link the $PM_{2.5}$, fire, meteorological, asthma and socio-economic data at the county level
 - Develop models to predict asthma exacerbations at the county level for weekly or monthly time periods
 - Validate the models using 2008 data
 - Assist the State of Florida in developing an alert system for asthma
 - Place results on Florida's Environmental Public Health Tracking Portal